NATURAL RESOURCES PROGRAM

REMOTE SENSOR AIRCRAFT DATA GATHERING SYSTEM
DATA PROCESSING AND DISTRIBUTING UNIT

Prepared by

Natural Resources Program
Space Applications Programs Office (OSSA)

In Cooperation With
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REMOTE SENSOR AIRCRAFT DATA GATHERING SYSTEM DATA PROCESSING AND DISTRIBUTING UNIT

I. PURPOSE AND OBJECTIVES[1, 2]

The Natural Resources Program (NASA/OSSA/SAR) is accumulating data recorded by several kinds of remote sensors, both electromagnetic and force-field, onboard NASA-conducted aircraft and other cooperating flights over selected geoscience test sites; additional calibration and ground-reference data is also collected at some specific ground-site installations using contact or short-range sensors for correlation and corroboration of the airborne remote-sensor data. The purpose of such collections is to aid in evaluating the usefulness of apparatus and data analysis techniques for remote sensing of natural and cultural resources by means of spaceborne instrumentation. Preliminary evaluation of data already collected offers highly favorable evidence that the advanced, state-of-the-art techniques under investigation by the Program will provide significant contributions to the remote sensing of natural

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1. NASA/OSSA, Natural Resources Program, The Remote Sensor Aircraft Data Gathering System, March 1966.

2. NASA,OSSA, Space Applications Programs Office, The Natural Resources Program--Test Sites, March 1966.

resources in four major disciplines of application, namely (a) agriculture/forestry, (b) geology/hydrology, (c) geography/cartography, and (d) oceanography/marine technology. The Data Processing and Distributing Unit (or Data Unit) has been established to handle the data resulting from the aircraft flights over test sites and from other feasibility studies by the investigators supporting the Natural Resources Program.

The Data Processing and Distributing Unit is required to handle the data generated by various onboard and on-ground sources. This involves a number of different data formats (film, paper, tapes, charts, etc.) providing records which present the data in a variety of forms, i.e., digital, analog, alpha-numeric, etc. A better understanding of the overall data handling effort to be supplied by the data unit can be obtained from Charts 1-5 which describe the experimental activities required by the major areas of application for 1966-1969 (aircraft) and 1969-1972 (spacecraft). Outputs for these overflights will come from sixteen principal data-gathering remote sensors plus some ground readout data; as noted in these listings, various sub-groups of the sixteen sensors are required for any given overflight involving specific ground-side observations. Appendix I offers explanatory titles for these sensors which are listed in abbreviated form in Charts 1-5.

The NASA data management system includes such facilities as the NASA Space Science Data Center at Goddard Space Flight Center, Technical Information Divisions, Libraries, and storage points. These facilities receive data in the form of technical reports, publications, and reduced data. Unreduced data, reproduction of raw data, preliminary findings, field and laboratory notes are not normally introduced into nor distributed by the general NASA data storage and retrieval system until they are available in a reduced form such as a technical report or summary.

In a summary, the scientists engaged in support of the NASA Natural Resources Program require high-quality imagery and accurately processed nonimaging data whose turnaround time from acquisition through processing and distribution must be sufficiently rapid to a) influence succeeding experiment overflight plans, b) accommodate data interpretations based on time-varying conditions at selected sites, and c) quickly expose any needed modifications of equipments as a result of prior data evaluation. The same data, e.g., photographs, radar imagery, etc., is useful to several or perhaps all of the disciplinary areas. Hence it is redundant and unnecessarily costly in both time and money for each of the experimenters to support a separate specialized data processing system.

II. STATUS OF THE DATA UNIT

A. Organization

Data from some nine aircraft missions plus other sub-missions from supporting investigators have been handled during the past year by the established Data Processing and Distributing Unit. This Unit is located at the NASA Manned Spacecraft Center. Figure 1 illustrates the aircraft data work plan and flow chart for the Data Unit. Requests for data and services should normally be directed to the Data Unit, attention Mr. Edward Zeitler.

The Data Unit established under the foregoing control offers the integrated operation needed by the Natural Resources Program for the handling of its data. Such integration is provided by:

1. The people responsible for evaluating the instrumentation, and potential correlations between data, installing the equipments (both aircraft and, say pallet mounts in the spacecraft), operating the equipments and acquiring data, annotating experimental conditions, recovering the raw data,

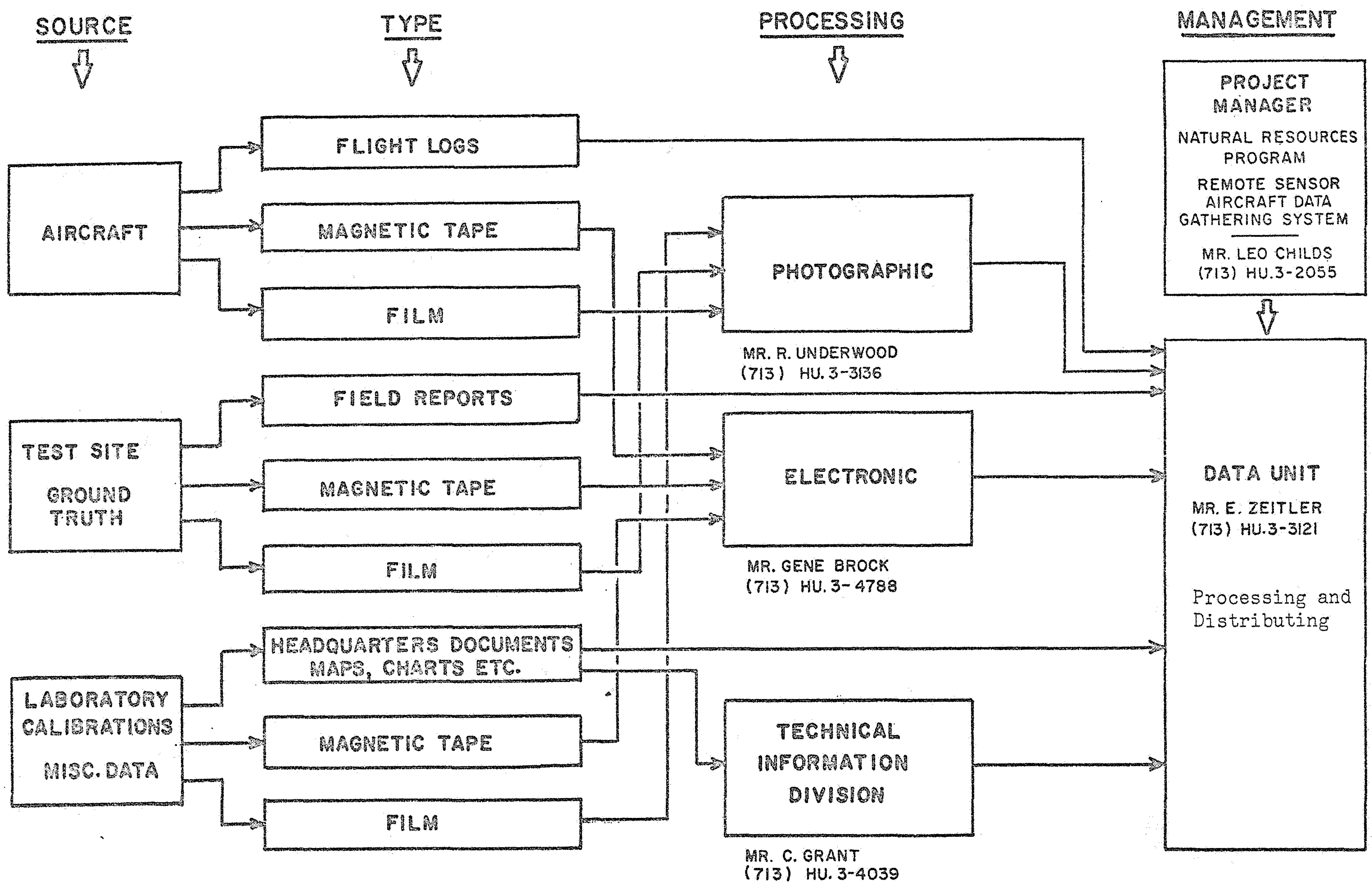

FIGURE 1: DATA WORK PLAN AND FLOW CHART

are all located under a single central control which provides the conveniently continuous liaison necessary for accurate, rapid handling of large amounts of data.

2. This Center, in its Apollo support, had already gained some remote sensor experience directly related to the needs of the Natural Resources Program; prior contract for radar scatterometry is cited as one example.

3. The Natural Resources Program will be dependent on the training given to the astronaut in the operation of the spaceborne remote-sensor experiments. This was anticipated in the selection of the integrated control that has been established at MSC.

4. The ongoing aircraft test program at MSC has already delineated the kinds and amount of data to be handled and has provided the initial training of personnel to form the nucleus necessary for the expanded program.

5. The established Unit has had numerous and extensive contacts with the supporting scientific investigators which has provided the necessary, detailed liaison between takers and users of the data. This experience is extremely important inasmuch as the ultimate interpretation of data is heavily dependent on the details associated with the taking of the data.

B. Equipment and Facilities

The Data Processing and Distributing Unit has extensive facilities for handling the present data load but will require some expansion of both personnel and equipment to handle the anticipated load expansion as suggested in Charts 1-5. Among the more significant pieces of equipment at the Unit and which constitute a sizeable investment are:

1. Electronic Processing

   a. Variable-delay, comb-filter networks

   b. Magnetic tape recorder bank for signal conversions and tape dubbing (0.25-1 inch)

   c. Spectrum system of narrow band comb filters (for unique processing of specific radar data and other narrow band requirements)

   d. MSC Data Reduction Complex includes a large computer facility and programming support. Some of the available functions pertinent to the processing of resource data are the conversions from analog-to-digital and digital-to-analog outputs, CRT plot outputs (i.e., CRT to photo), binary data to X-Y plots plus annotation data recording, analog/FM data format to digital computer-compatible tapes.

   e. Microfilm data handling and reproducting equipment including aperture card data outputs

   f. Photographic viewing tables.

   Expansion in terms of equipment for electronic processing is not indicated by present estimates for the future work load. Some need may exist for additional broad-band VCO data conversion from frequency to analog outputs to satisfy the passive microwave data processing which is presently being supplied by the supporting investigator. With an expansion in personnel only to permit processing in parallel as opposed to series operations, the electronic processing facility will be capable of maintaining a 14-day turn-around time for the four-fold increase in data load estimated for the expanded program; present turn-around time is about 1-2 weeks.

2. Photoprocessing Equipment

On Hand:

a. Photogrammetric rectifier

b. Electronic contact printer

c. Sonne printer

d. FE-120 Zeiss tank processor

e. Zeiss aerial film dryer

On Order:

a. Precise photogrammetric rectifier

b. Continuous electronic strip printer

c. Color film processor, automatic

d. Color continuous printer

e. Light tables

These or similar items may be purchased in FY 1966 and FY 1967:

a.	Electronic contact and projection printer	$17	K
b.	Automatic B/W film processor	20	K
c.	Microdensitometer/tracer	45	K
d.	Ultrasonic film cleaner	27.5	K
e.	Electronic color contact printer	15	K
f.	Electronic, 10 x 10 enlarger	13	K
g.	Rear projection view/printer, variable scale	39	K

i. Chemical storage equipment 35 K

j. Film titler 17.5 K

At present, the major expense and delay in turn-around time (about 45 days) is in film processing provided by contract outside the data facility. Some personnel expansion, perhaps by contract, in the photo-processing facility with the additional equipments shown above is needed to allow in-house film processing and the turn-around time for the projected work load (approximately 4 times the present bulk) to be reduced to 7 days in contrast to the present 45 days.

III. <u>POLICY AND PROCEDURES IN DATA UNIT OPERATIONS</u>

This instruction promulgates policies and procedures for operation of the Data Processing and Distributing Unit, applicable to NASA Headquarters and Field Installations.

A. <u>Definitions</u>

<u>Analyzed Data</u>. Data that have been reviewed and correlated to form the basis for a scientific or technical publication.

<u>Principal Investigator</u>. In the Natural Resources Program much of the experimental instrumentation is NASA-provided equipment so that the scientists involved may be considered as user investigators. The person responsible for a scientific investigation, or the individual scientists where there is only one investigator.

<u>Co-Investigator</u>. One of a number of scientists collaborating on a single investigation under the direction of a principal investigator.

Experiment Equipment. Equipment installed in NASA aircraft, NASA-supported aircraft, cooperating aircraft, or on the ground for the conduct of a scientific investigation or experiment.

Original Data Records. Data recorded onboard the aircraft on film, paper, plastic or magnetic tapes, and/or other recording media, as well as those data records made by ground stations receiving telemetered data or data records of ground control information collected in support of the NASA/OSSA/SAR Natural Resources Program.

Program. A related series of undertakings which continues over a period of time (normally years), and which is designed to accomplish a broad scientific or technical goal in the NASA Long Range Plan. Program responsibility is assigned to the appropriate program office within NASA Headquarters. In the case of the Data Processing and Distributing Unit the Headquarters responsibility has been assigned to the Office of Space Science and Applications.

Program Chief. A senior scientist at NASA Headquarters responsible for a broad area of scientific investigation. In the case of the Data Processing Unit it is the individual in the Office of Space Science and Applications who is responsible for the direction of the NASA Natural Resources Program.

Project Manager. The individual, normally at a NASA Field Center, who is assigned the direct responsibility for project execution. In the case of the Data Processing Unit, it is the individual at the Manned Spacecraft Center who is responsible for the management of this unit (see Figure 1).

Reduced Data Records. Records prepared from original data records by editing, introduction of calibration factors, and interrecord identifications. They will contain a minimum of extraneous information and/or noise. Generally, they will present the value of the physical quantity measured as a function of time and position. These records, or graphs and tabulations prepared therefrom, are used by the experimenter for analysis and provide a basis for his conclusions.

Remote Sensing. The study of remote objects (Earth, lunar, and planetary surfaces and atmospheres, stellar and galactic phenomena, etc.) from great distances. Remote sensors are optical, electro-optical, and electronic sensing devices which are used for the purpose of such studies.

B. Policy

a. It is NASA policy that data derived from the conduct of the Natural Resources Program should be managed by the Data Unit where it can be made available to NASA-supported investigators at no or minimal cost.

b. Specific policy guidance, as required, on storage, release, and disposition of data will be provided by NASA. Policy guidance will:

(1) Insure that the time interval for the investigator's analysis and evaluation of data is respected for the agreed upon period of time.

(2) Consider the advice of the OSSA/SAR Natural Resources Program Coordination Panel comprised of representatives or designees from the following agencies:

National Aeronautics & Space Administration
U.S. Department of Agriculture
U.S. Department of Commerce
U.S. Department of Interior
U.S. Department of Defense
National Academy of Sciences--National Research Council

c. Exceptions to policies and procedures governing operation of the Data Unit may be recommended by the subgroup for approval by NASA. Authority to make specified modifications or exceptions may be delegated by the Project Manager of the Data Unit. If no consensus exists, then a request for decision will be forwarded through the normal chain of command.

d. Dissemination of Data:

(1) In the case of data collected in the air or on the ground at the NASA common test sites, it is the policy of NASA that these data must be made promptly available on an equal priority basis to all NASA-supported investigators upon request. Unless an official request is made and authorized by NASA, the Data Unit normally will not release original or reduced data to other investigators until 60 days after its delivery by the Manned Spacecraft Center to the original investigator requesting the data, nor earlier than the contractually agreed upon time. When exceptions to this policy are authorized, the original investigator will receive prior notification of intent to release data before expiration of the 60-day period.

(2) The requirement for prompt delivery of data to the Data Unit by NASA-supported and cooperating scientists is not intended to interfere with the research work in progress of these scientists. If they must retain continuity of original data records until a particular mission requirement has been met, then duplicate records should be submitted. The originals should be submitted as soon as they have been processed and/or analyzed.

(3) The Data Unit may release data to any NASA-sponsored investigator on request 60 days after the data was delivered to the original investigator or after expiration of the contractually agreed upon time. Data collected by and for an investigator may be released by him to others after prior arrangement and agreement with the Data Unit

C. Operation of the Data Unit

a. General

(1) Operation of the Data Unit will be in consonance with the policies outlined in paragraph III above.

(2) The Data Unit will consist of all personnel, equipment, and facilities for retrieval, processing, reproduction, classification, indexing, cataloging, dissemination, storage, and deposition of data derived from the NASA Natural Resources Program. The Data Unit does not include the airborne sensors which will acquire the data nor the test sites.

b. Responsibility

The Manned Spacecraft Center (MSC), Houston, is designated the responsible NASA Field Center for establishment and operation of the Data Unit under the technical guidance of the Office of Space Science and Applications Natural Resources Program Office. The Project Manager for the Natural Resources Program Remote Sensor Aircraft Data Gathering System at MSC will provide technical supervision of the Data Unit.

c. Functions

The Data Unit will perform the following functions in support of the NASA Natural Resources Program:

(1) Process, reproduce, catalog, classify, index, disseminate, store, and retrieve geoscience data (original, reduced and/or analyzed, including preliminary, intermediate and final reports) received from NASA supported, or cooperating remote sensing of natural resources investigators.

(2) Provide supplemental support by maintaining an adequate supply of charts and maps relating to test sites and by conducting file searches and related services. Such charts and maps will be supplied from standard sources.

(3) Compile and furnish periodic accession lists of data to cooperating investigators. Accession lists will indicate type and size of format, originator, sensor type, geographic area, altitude, time and date of acquisition by originator. This information may be in the form of computer print-outs.

(4) Design and supply check lists to investigators for submission of data to the Data Unit. These check lists will contain minimum terms, descriptors and information required to provide a basis for data cataloging and entry into a computer or other retrieval system.

(5) Design a format for queries to the Data Unit and make copies available to investigators for their use.

(6) Process, reproduce, associate with related sensor data, catalog, classify, index, disseminate, store and retrieve all ground control data from test sites supplied by investigators who support the NASA Natural Resources Program.

d. Notification of Data Collection

Investigators participating in the NASA Program will provide immediate written notification to the Data Unit of new data collection. Notification should not be delayed until actual submission of the newly collected data.

e. Submission and Processing of Data

(1) Data collected by NASA multisensor aircraft will be processed by the Data Unit at MSC, Houston, Texas within two weeks after the aircraft returns to Houston. The processed data will then be forwarded immediately to those investigators for whom it was acquired. Investigators who have data processing requirements that are critical to the success of their investigation and who wish to process their own data, should so advise the Data Unit. In such cases, the Data Unit will send the unprocessed records to the investigator to be processed by him. If the investigator must retain the original processed record for his work, he shall send a first generation copy of high quality to the Data Unit.

(2) Investigators participating in the NASA Natural Resources Program who use non-NASA multisensor aircraft over NASA test sites or over non-NASA test sites should notify the Data Unit concerning the collected data. Such investigators should process their own data and send the original copy to the Data Unit unless the nature of their experiment require use of the original copy of the data. In such cases, a high quality first generation copy shall be sent to the Data Unit. The facility will, on

request of the investigator, process data collected under such circumstances in accord with instructions of the investigator and will retain the original copy and provide the investigator with a first generation copy. An exception will be made if the investigator requires the original copy.

(3) When original data records are submitted to the Data Unit for processing and/or storage, a suitable copy of the data will be provided to the originator if requested by him. It is the policy of NASA that custody of all original data from investigators under contract to NASA, except field notes and raw data of value only to the originator should ultimately be stored at the Data Unit. Investigators using the Data Unit or submitting data to it should provide all necessary information related to the experimental conditions existing during the collection of the data. This will facilitate subsequent use and interpretation of the data.

(4) The agencies who are developing applications of remote-sensor-acquired data will necessarily organize and operate specialized data-processing sections. Their efforts will be aimed at solving the technical problems relating to analysis and specific signature discrimination determination during the experimental phases of the program and at defining the data management problems which will arise as they become users of data from the future operational phase. Each of these data facilities, as well as individual investigators, will interchange data and technical information

through the Natural Resources Data Processing and Distributing Unit during the course of the Natural Resources Program.

f. Security

The Data Unit will be governed by NASA policies and regulations with respect to security as contained in NASA Management Manual 24-1-1. Questions concerning security will be referred by the Project Manager of the Data facility to the appropriate NASA Security Office directly or through the Program Chief, Natural Resources, as indicated by the nature and timing of the problem.

g. Disposition of Records

The Data Unit will advise investigators when data are considered to be excess to program needs. Investigators should advise the Data Unit on receipt of notification of impending disposal of records if they or their agency or any academic/scientific agency wishes to obtain the records for their own use.

IV. WORK LOAD ESTIMATES FOR THE DATA UNIT

A. Aircraft Program

Based on the user requests for aircraft overflights, Charts 1-5, the estimated requirement for flight hours has been tabulated as shown below:

ESTIMATED REQUIREMENT FOR AIRCRAFT
(TIME OVER TEST SITES)

	FY 1/2 1966	FY 1967	FY 1968	FY 1969	FY 1/2 1970	TOTAL
Agriculture	12	85	136	122	31	386
Geography	5	74	12	12	11	87
Geology	69	395	281	238	158	1141
Hydrology	85	242	359	360	180	1226
Oceanography	55	145	170	160	75	605
Total Requested Hours	226	914	958	892	455	3445

The total amount of time each aircraft can spend in the actual gathering of data is a function of total budgeted time for the aircraft. The total projected time for gathering of data by the CV-240A and P-3A is approximately 300 hours/year (time over test sites). The latter figure provides the basis for the succeeding estimate of data bulk to be handled by the Data Unit during the peak period (1967-1969) of data collection from aircraft platforms.

The tabulation of data bulk for the peak years shown below is an averaged estimate based on present MSC operating experience. A detailed breakdown per overflight (Charts 1-5) is unavailable and could be misleading since the amount of data collected during any given run can vary radically with such conditions as aircraft motion, navigational problems, weather conditions, instrument operability, etc. Detailed data requirements by experiment have been estimated.[3]

AVERAGED ESTIMATE OF AIRCRAFT DATA BULK
(Per Year)

1" magnetic tape, 10.5" reel (3600 ft)	1500 reels
35mm film, 180 ft/roll	63 rolls
70 mm, film, 150 ft/roll	1200 rolls
70 mm, film, 180 ft/roll	700 rolls
5 inch, film, 200 ft/roll	360 rolls
9.5 inch, color film, 180 ft/roll	375 rolls
9.5 inch, color IR film, 180 ft/roll	375 rolls
9.5 inch, B/W film, 180 ft/roll	54 rolls

In addition to processing of the above raw data, the Unit will provide reproductions of the originals for experimenter requests. For example, present activity has required a dubbing or copy/original ratio of about 2:1 for magnetic tape data. It is anticipated that such ratio will increase significantly with the peaking of the program. In addition the Data Unit will handle other data submissions (test site data, flight logs and navigation maps, charts, etc.) whose bulk will be relatively small compared to that listed above.

3. NASA, Remote Sensing Data Facility (MSC), "Analysis of Remote Sensing Data Requirements by Experiment".

FUNDING REQUIREMENTS

			Thousands
FY. 1966	**remaining funds, approximately**		**220**
Data Processing and Distribution Photographic, imagery, and spectral media processing; in-house and contract.			146
Equipment			
Automatic B/W film processor	20		
Electronic contact and projection printer	11		
Electronic color contact printer	15		
Temperature controlled sinks	15		
Electronic, 10 x 10 enlarger	13		
	74		74
		Total	220
FY 1967	**Funding in obligation plan**		**750**
Data Processing and Distribution Photographic, imagery, and spectral media processing; in-house and contract.			586
Equipment			
Microdensitometer/tracer	45		
Ultrasonic film cleaner	27.5		
Rear projection view/printer, variable scale	39		
Chemical storage equipment	35		
Film titler	17.5		
	164.0		164
		Total	750

B. Spacecraft Programs

Data bulk estimates have been made for spaceborne coverage of the Earth. These have been based on the coverage required by supporting investigators and do not represent any engineering checkout operation where emphasis is on instrument evaluation as opposed to the needed collection of data for scientific interpretation.

ESTIMATE OF SPACECRAFT DATA BULK

(Electronic Processing - All data on 1" magnetic tape)

1. IR Spectrometry, 3300 ft/reel	- 6 reels
2. Absorption Spectroscopy, 3600 ft/reel	- 3 reels
3. Passive Microwave Emission, 3000 ft/reel	- 2 reels
4. Scatterometer/Altimeter, 3600 ft/reel	-13 reels
5. RF Reflectivity, 1000 ft/reel	- 1 reel
6. Micrometeorite Detection, 3000 ft/reel	- 2 reels

(Photoprocessing)

1. Metric Cameras, 9.5 inch film, 1100 ft/roll	- 8 rolls
2. Multispectral cameras, 9.5 in film, 1100 ft/roll	- 4 rolls
3. UHR Camera, 70 mm film, 2200 ft/roll	- 2 rolls
4. Stellar Camera, 70 mm film, 1500 ft/roll	- 2 rolls
5. IR Imager, 70 mm film, 400 ft/roll	- 1 roll
6. Panoramic Cameras, 5.5 inch film, 5500 ft/roll	- 2 rolls
7. Passive Microwave Imager, 70 mm Kalvar film, 50 ft/roll	- 1 roll
8. Radar Imager, 56 mm film, 5500 ft/roll	-10 rolls
9. UV Absorption/Luminescence, 35mm film, 2100 ft/roll	- 2 rolls

Appendix I

EXPLANATION OF EXPERIMENT ABBREVIATIONS IN CHARTS 1-5

Parameter descriptions of the following experiments may be found in:

1. NASA/OSSA, Advanced Missions Division, Manned Earth Orbital Missions (2nd edition), November 1965.
2. NASA/OSSA, Natural Resources Program, The Remote Sensor Aircraft Data Gathering System, March 1966.

Abbreviation	Title
Mc	Metric Camera Photography
Pc	Panoramic Camera Photography
UHR	Ultra-high Resolution Photography
MB	Multi-band (spectral) Photography
IRI	Infrared Imaging
IRS	Infrared Spectrometry
MWI	Passive Microwave Imaging
MWS	Passive Microwave Spectrometry
RAD I	Radar Imaging
RAD A/S	Radar Altimetry and Scatterometry
LAS	Laser Altimetry
MAG	Magnetometer Experiment
GRAV	Gravity Gradiometer Experiment
UHF	RF-VHF Reflectivity
UV	Ultraviolet Absorption/Luminescence
ABS	Absorption Spectroscopy.

[illegible] AND (2) SPACECRAFT DATA GATHERING SYSTEMS

AIRCRAFT OVERFLIGHT AND HOURS PER CY														SPACECRAFT OVERFLIGHTS DESIRED						
[illegible]		67				68				69				69				70	71	72
4	[illegible]	4	4	4		4	4	4	4		4			X	X	X		YES	YES	YES
		2	2	2		2	2	2		2	2	2		X	X	X		YES	YES	YES
2		2	2	2		2	2	2		2	2	2		X	X	X		YES	YES	YES
	2	3	3	3	6	3	3	3		3	3	3		X	X	X		YES	YES	YES
	2													X	X	X		YES	YES	YES
3		3	3	3	3	3	3	3	3	3	3	3	3	X	X	X		YES	YES	YES
		3	3	3	3	3	3	3	3	3	3	3	3	X	X	X		YES	YES	YES
7			2											X	X	X		YES	YES	YES
		2	2		2	2	2		2	2	2		2	X	X	X		YES	YES	YES
			2	2			2	2			2	2		X	X	X		YES	YES	YES
			8		8		8		8		8		8	X	X	X		YES	YES	YES
			17	17			15	15												
					10	10			12	12										
[illegible]	22	19	43	31	32	29	34	34	32	21	29	15	16							
		125				139				87										
85				136				122				31								

The test sites to be viewed depend upon the inclination of the spacecraft orbit

CHART 1.

AGRICULTURE LIST OF NATURAL RESOURCE EXPERIMENTS TO BE CONDUCTED BY (1) AIRCR

TITLE OF EXPERIMENT	SPECIFIC APPLICATION (OR GEOSCIENCE PROBLEM) PHENOMENA AND PARAMETERS TO BE MEASURED, INTERPRETIVE FEATURES TO BE STUDIED	TEST SITES TO BE UTILIZED	AGENCY, INSTITUTION AND INVESTIGATOR (s) RESPONSIBLE FOR DATA ANALYSIS	PRINCIPAL DATA GATHERING INSTRUMENTS REQUIRED														
				MC	PC	UNR	MB	IRI	IRS	MWI	MWS	RAD I	RAD A/S	LAS	MAG	GRAV	UHF	Uv
Remote multispectral sensing in agriculture	Multispectral response signatures of corn belt crops and soils. Amount and source of variation of signatures for selected soil condition and crop species. Relate ground response to predicted orbital altitude response.	Purdue University and the vicinity of Lafayette Indiana.	USDA, Purdue Univ. HOLMES HOFFER	X	X	X	X	X	X		X	X	X					X
		Western Kansas	Ralph Shay	X	X	X	X	X	X		X	X	X					X
	Multispectral response signatures of California crops and soils. Thermal IR study on crops and livestock. Soil type and moisture study.	Davis California and vicinity.	USDA Univ. of Calif. ROBERT COLWELL	X	X	X	X	X	X		X	X	X					X
	Multispectral response signatures of Westlaco Texas crops and soils	Westlaco Texas and vicinity	USDA ARS Soil and water conservation research division. VICTOR MYER	X	X	X	X	X	X		X	X	X					X
Identity study of California forest species by means of high altitude small scale aerial photography	Differentiation of eucalyptus and monterey pine Study of growth admixture Determine smallest size of tree and clump of trees.	San Pablo reservoir California	USDA US Forest service DONALD LAUER	X	X	X	X	X	X		X	X	X					X
Interpretability of high altitude color photography and spectrazonal photography in evaluation of wildland resources.	Water resources - stream flow volume Soil resource - type and depth Forage resource - animal carrying capacity Fish, wildlife, & recreation resources	Sierra Nevada mountains coast range of California Hunter-Liggett area, Calif. Harvey valley, Calif	USDA US Forest service DAVID CARNEGGIE University of Calif. ROBERT COLWELL	X	X	X	X	X	X		X	X	X					X
	Timber resources.			X	X	X	X	X	X		X	X	X					X
Root disease impact on forests	Multiple sensing techniques on Douglas fir trees	Oregon & Washington	USDA US Forest service JOHN WEAR	X	X	X	X	X	X		X	X	X					X
Stress from insect or disease-detection in Ponderosa pine	Ascertain if multispectral sensing will detect infested pine during the 3-9 month lead time between infestation and death signs.	Fort Collins Colo. Berkely Calif.	USDA US FS ROBERT HELLER	X	X	X	X	X	X		X	X	X					X
Semi tropical and tropical plant identification by multispectral sensing	Plant signatures, emission studies, soil series and type	Homestead Fla.	USDA & ARS (Investigator to be selected)	X	X	X	X	X	X		X	X	X					X
Tropical forests	Multiple sensing techniques applied to species identification of tropical trees	Yucatan Penninsula, Mexico (for planning purposes)	Univ of California ROBERT COLWELL	X	X	X	X	X	X		X	X	X					X
Tropical forests, crops, soils	Multiple sensing techniques applied to species identification of tropical trees and crops; soils studies	Quadrilatero Ferrifero, Brazil	Purdue U. R. SHAY															
Desert crops, soils, and flora	Multiple sensing technique to identify desert crops, soils, and general environment	Alice Springs, Australia	Kansas U. D. SIMONETT															

TOTAL HOU

TOTAL HOURS

TOTAL HOURS

This chart reflects the needs of the U. S. Department of Agriculture and of the Agriculture and Forestry community compiled by the Department of Agriculture

INSTRUMENT ABBREVIATIONS LEGEND:

MC-Metric Camera, PC-Panoramic Camera, UHR-Ultra-High Resolution Camera (Multispectral), MBS-Multiband IRS-Infrared Spectral, MWI-Microwave Imaging, MWS-Microwave Radiometers, RAD (I)-Imaging Radar, RAD (A LAS-Laser Altimeter/Scatterometer, MAG-Magnetometer, GRAV-Gravity Gradiometer, UHF-Radio Frequency Pulse Emission, ABS-Absorption Spectroscopy

...E SUPPORTED BY (1) AIRCRAFT AND (2) SPACECRAFT DATA GATHERING SYSTEMS

PRINCIPAL DATA GATHERING INSTRUMENTS REQUIRED													AIRCRAFT OVERFLIGHT HOURS REQUIRED																SPACECRAFT OVERFLIGHTS DESIRED			
IRS	MWI	MWS	RAD-I	RAD	A/S	LAS	MAG	GRAV	UHF	UV	AB/S	ON GROUND READOUT	1966				1967				1968				1969				1969	1970	1971	1972
X	X	?	X	?			?	?		X	X	X			1	1	1	1	1	1	1	1	1	1	1	1				Yes over whole TVA	Yes over whole TVA	Yes over whole TVA
X	X	X	X				?			X	?	X					3	3	3	3									Yes over U.S.	Yes over N. Amer. & Europe	Yes	
X	?		X	X						X		X		4				10												YES		
?	X	?	?							X		?											6						YES	YES		
X	?		X	X						X		?						24												YES		
	X																AS REQUIRED TO FILL GAPS NOT AVAILABLE IN DATA ACQUIRED FOR OTHERS												X X X X	X X X X	X X X X	X X X X
														1 1	1	1		1	1	1		1	1	1		1	1	1	X X X X	X X X X	X X X X	X X X X

* STEREO PANORAMIC CAMERA PRIMARY SYSTEM REQUIRED

TOTAL HOURS PER QTR		5	2	2	4	39	5	5	1	1	7	2	1	1	1	1
TOTAL HOURS PER CY	9				53				1				4			
TOTAL HOURS PER FY	5		47				12				11				12	

...Resolution Camera (Multispectral), MAS-Multiband Synoptic, IRI-Infrared Imaging, ...crowave Radiometers, RAD (I)-Imaging Radar, RAD (A/S)-Radar Altimeter/Scatterometer, ...AV-Gravity Gradiometer, UHF-Radio Frequency Pulsed Radar, UV-Ultraviolet Absorption/

CHART 2.

GEOGRAPHIC LIST OF NATURAL RESOURCE PROJECTS TO BE SUPPORTED BY (1) AIRCRAFT AND

TITLE OF EXPERIMENT PROJECT	SPECIFIC APPLICATION (OR GEO-SCIENCE PROBLEM) AND PARAMETERS TO BE MEASURED, INTERPRETIVE FEATURES TO BE STUDIED	TEST SITES TO BE UTILIZED AND OBJECTIVE AREAS	AGENCY AND INVESTIGATORS RESPONSIBLE FOR DATA	PRINCIPAL DATA GATHERING INSTRUMENTS REQUIRED																
				MC	PC	UHR	MBS	IRI	IRS	MWI	MWS	RAD-I	RAD	A/S	LAS	MAG	GRAV	UHF	UV	AB-
Regional Analysis	Land-surface forms Natural vegetation deciduous forest coniferous forest brush Distribution of crop types and conditions Urbanized limits Transportation networks Historic sites and routes Settlement patterns Economic activities Age and composition of buildings Rock types Hydrologic characteristics	Ashville Basin (48) Quadrilatero Ferrifero, Brazil Alice Springs, Aust.	E. TENNESSEE STATE R. Peplies (x) N. Nunley (Co) R. Darling (Co) F. Newby (Co) M. C. Young (Co) W. D. Braddock (Co) L. A. Brown (Co) D. E. Harrell (Co) F. Barclay (Co) McGILL UNIV. T. L. Hill (x) J. B. Bird (Co) U. OF KANSAS D. Simonett (x)	?	v	?	X	X	X	X	?	X	?			?	?		X	X
Urban and Transportation Information Systems	Urban structure and spatial distribution of functions Transportation networks Traffic surveillance Population distribution and movement	Chicago (and S. E. Wisconsin (43) Phoenix (29) Lagos-Ibadan, Nigeria	NORTHWESTERN U. GEOG. DEPT W. Garrison (x) D. Marble (co-) E. Thomas (Co) M. F. Dacey (Co)	X	X	X	X	X	X	X	X	X				?			X	?
Summer Resort Development in Glaciated Terrain	House types and ages Settlement patterns and growth Transportation networks and traffic volume	N. Minnesota & Wisconsin	U. OF MINNESOTA GEOG. DEPT J. Borchert (x) P. Porter (Co)	X	X	X	X	X	X	?		X	X						X	
Glaciological Applications	Ice conditions and movements Hydrologic implications	So. Cascade Glacier (40)	USGS - M. Meier Campbell (co-) OWR - R. Alexander (Co)	X		?	X	X	?	X	?	?							X	
Central America Population Study	Settlement patterns and movements Population count Transportation and traffic Land use patterns	Central America	U. OF KANSAS & PAIGH R. Nunley (x) J. Augelli (co-)	X	X	X	X	X	X	?		X	X						X	
Development of Interpretation Keys and Analysis of Returns	Identification of regional geographic phenomena	Appropriate data will be selected from that obtained for Geol. Geog., Hydr., Agric. and Oceano.	GIMRADA R. A. Leestma (x) R. E. Jones (Co) R. A. White (Co)	X	X	X	X	X		X										
Cartographic and Topographic Applications	Revision of published maps and preparation of new maps of remote areas.	Arizona Test Range and areas, as appropriate, from those of other disciplines.	USGS - W. Sibert (x)	X	X*	X														

DATA REQUESTED BY EXPERIMENTORS, AND CHART COMPILED BY APPLICATION OFFICE FOR GEOGRAPHY

* STEREO PANORAMIC CAMERA
PRIMARY SYSTEM REQUIRED

TOTAL

TOTAL

TOTAL

This chart reflects the needs of the U. S. Geological Survey and the geographic community compiled by the U. S. Geological Survey

INSTRUMENT ABBREVIATIONS LEGEND:

MC-Metric Camera, PC-Panoramic Camera, UHR-Ultra-High Resolution Camera (Multispectral), MBS-Multiband Synoptic, IRI-Infrared Im[illegible] IRS-Infrared Spectral, MWI-Microwave Imaging, MWS-Microwave Radiometers, RAD (I)-Imaging Radar, RAD (A/S)-Radar Altimeter/Scatterometer, LAS-Laser Altimeter/Scatterometer, MAG-Magnetometer, GRAV-Gravity Gradiometer, UHF-Radio Frequency Pulsed Radar, UV-Ultraviolet [illegible] Emission, ABS-Absorption Spectroscopy

...S TO BE CONDUCTED BY (1) AIRCRAFT AND (2) SPACECRAFT DATA GATHERING SYSTEMS

PRINCIPAL DATA GATHERING INSTRUMENTS REQUIRED													AIRCRAFT OVERFLIGHT HOURS REQUIRED PER FY YEAR																SPACECRAFT OVERFLIGHT DESIRED			
IRI	IRS	MWI	MWS	RAD (I)	RAD (A/S)	LAS	MAG	GRAV	UHF	UV	ABS	ON GROUND READOUT	1966 1/ 2/				1967				1968				1969				1969	1970	1971	1972
x							X									40		20		20		20		40		20		20	YES	YES	YES	YES
x																20		20		20		20		20		20		20	YES	YES	YES	YES
x															20								20				20		YES	YES	YES	YES
x																							20				20		YES	YES	YES	YES
x							X												20				20				20		YES	YES	YES	YES
x	X																		20				20				20		YES			
x	X																		20				20				20		YES			
x	X																	20											YES			
x	X																20												YES			
x	X																20												YES			
x																2		2			2							2	YES			
x																2		2			2							2	YES			
x	X																												YES	YES	YES	YES
x																																
x										X		HIGH NOON 10 - 2 PM		5	5			5	5										YES			
x										X				5	5			5	5										YES			
x										X				5	5			5	5										YES			
x										X				5	5			5	5										YES			
x	X			(X)								X		4		4			4		4							4	YES	OPEN	OPEN	OPEN
(X)	X	X	X	(X)	X							X																				
(X)	X	X	X	(X)	X							X																				
(X)	(X)	X	X	(X)								X																				
x	X			(X)								X		4		4			4		4							4	YES			
												X																				
x	X											X			1					1		1			1				YES			
					X							X			1					1		1			1				YES			
x	X											X			4				4				4				4		YES			
x	X	X	X									X																	YES			
				X	X							X			1				1				1				1					
x	X	X	X	X	X							X						1			1								YES			
				X	X							X							1										YES			
				X	X							X							1										YES			
				X	X							X							1										YES			
				X	X							X							1										YES			
x	X			X	X							X		2															YES			
x	X											X		2															YES			
							X					X	← (725) each Quarter →																YES			
(X)	X			X								X				1													YES	OPEN	OPEN	OPEN
				X	X					X		X			4				4										YES			
x				X											1														YES			
x				X											2														YES			
x				X												20													YES			
x				X											1														YES			
x				X											1														YES			
x				X											1														YES			
x				X										3															YES			
x				X										1															YES			
x				X										1															YES			
x				X											3														YES			
x				X											1														YES			
x				X												3													YES			
x				X											3														YES			
x				X										6															YES			
x				X										1															YES			
x				X										1															YES			
														1															YES			
x				X										1															YES			
x				X											1														YES			
x				X											1														YES			
x				X											3														YES			

(X) indicates primary instruments, others serve for backup data

INSTRUMENT ABBREVIATIONS LEGEND:

MC-Metric Camera, PC-Panoramic Camera, UHR-Ultra-High Resolution Camera (Multispectral), MBS-Multiband Synoptic, IRI-Infrared Imaging, IRS-Infrared Spectral, MWI-Microwave Imaging, MWS-Microwave Radiometers, RAD (I)-Imaging Radar, RAD (A/S)-Radar Altimeter/Scatterometer, LAS-Laser Altimeter/Scatterometer, MAG-Magnetometer, GRAV-Gravity Gradiometer, UHF-Radio Frequency Pulsed Radar, UV-Ultraviolet Absorption/Emission, ABS-Absorption Spectroscopy

CHART 3.

GEOLOGIC LIST OF NATURAL RESOURCES EXPERIMENTS TO BE CONDUCTED BY (1) AIRCRAFT

TITLE OF EXPERIMENT	SPECIFIC APPLICATION (OR GEOSCIENCE PROBLEM) AND PARAMETERS TO BE MEASURED, INTERPRETIVE FEATURES TO BE STUDIED	TEST SITES TO BE UTILIZED	AGENCY, INSTITUTION AND INVESTIGATOR (s) RESPONSIBLE FOR * DATA ANALYSIS	PRINCIPAL DATA GATHERING INSTRUMENTS REQUIRED															
				MC	PC	UHR	MBS	IRI	IRS	MWI	MWS	RAD (I)	RAD (A/S)	LAS	MAG	GRAV	UHF	UV	ABS
Thermal regime of volcanoes	Convective heat transfer of selected volcanoes	57) Hawaii	R. M. Moxham/ R. Lyon (Stanford)	X				X							X				
		Taal, Philippines	R. M. Moxham	X				X											
		64) Cascades (Calif., Oregon, Wash.)	R. M. Moxham	X				X											
		Vesuvius-Etna	R. M. Moxham	X				X											
		Iceland	J. D. Friedman	X				X							X				
Thermal properties of natural materials	Investigations in variation of surface temperature as a function of K, Ro and C	3) Mono Crater, Calif	Gordon Greene/R. Lyon	X				X	X										
		2) Pisgah Crater, Calif.	Gordon Greene/R. Lyon	X				X	X										
Compositional (IR Spectral) mapping	Investigate utilization of scanning spectral radiometer and spectrometer to map compositional parameters (minerology)	Indiana dunes, Ind	S. J. Gawarecki/R. Lyon	X				X	X										
		27) Salton Sea, Calif	S. J. Gawarecki/R. Lyon	X				X	X										
		White Sands, N. Mex.	S. J. Gawarecki/R. Lyon	X				X	X										
Geothermal power sources	Hot spring thermal anomalies and variations	27) Salton Sea, Calif	Gordon Greene/R. Lyon	X				X											
		72) Coso Hot Springs, Calif.	H. H. Waldron	X				X											
		74) Benton, Calif		X				X	X										
Global mean annual temperatures	Determine accuracy and precision with which IR radiometry can be used to determine absolute surface temperature vs. conventional meteorological data	World wide	R. M. Moxham	X				X											
Ultraviolet absorption and luminescence	UV reflectence of natural materials between 3000-4000 A° (Engineering checkout for lunar experiment-luminescence with spectrometer)	2) Pisgah Crater	W. Hemphill/R. Lyon	X				X										X	
		22) Meteor Crater	W. Hemphill/R. Lyon	X				X										X	
		51) Mesquite Ariz	W. Hemphill/R. Lyon	X				X										X	
		3) Mono Crater	W. Hemphill/R. Lyon	X				X										X	
Special purpose or instrument sites	Volcanic Terrain (Lunar analogue) Lith	2) Pisgah Crater, Cal.	S. J. Gawarecki	X				X	X			(X)							
			R. Lyon	(X)	X	X	X	(X)	X	X	X	(X)	X						
			J. Cronin, AFCRL	(X)	X	X	X	(X)	X	X	X	(X)	X						
			T. Whitten (NWU)	(X)	X	X	X	(X)	(X)	X	X	(X)							
	Volcanic Terrain (Lunar analogue) Lith	3) Mono Crater, Calif	J. D. Friedman	X				X	X			(X)							
			T. Whitten (NWU)																
			R. J. P. Lyon (Stanford)																
	Volcanic Terrain	14) Little Dragoon Mtns	S. J. Gawarecki	X				X	X										
	Dome	16) Solitario, Texas	S. J. Gawarecki	X									X						
	Lithology	50) Donner Pass	R. J. P. Lyon (Stanford)					X	X										
	Plutonic Rocks-Lithology	19) Sonora Pass	R. Speed, JPL	X				X	X	X	X								
			D. B. Slemmons (U. Nev.)	X								X	X						
	Dunes-Composition	25) Devils Playground	L. F. Dellwig (U. Kans)	X			X	X	X	X	X	X	X						
	Impact features (Lunar analogue)	26) Meteor Crater, Ariz	G. Schaber	X								X	X						
	Hydrology	33) Guadalupe River	L. F. Dellwig (U. Kans)	X								X	X						
	Structure	34) Ouchita Mtns.	L. F. Dellwig (U. Kans)	X								X	X						
	Structure	36) Spanish Peaks, Colo	L. F. Dellwig (U. Kans)	X								X	X						
	Lunar Analogue (volcanic)	71) Hopi Buttes, N. Mex	G. Schaber/G. Swann	X				X	X			X	X						
	Lithology	97) Cape Cod, Mass.	J. Cronin, AFCRL	X		●		X	X										
	Magnetics	USA ●	J. Zeitz	X											X				
Structural geology	San Andreas Fault, earthquake zone	4) Carrizo Plains, Cal.	R. E. Wallace/R. Moxham	(X)	X	X	X	(X)	X			X							
	Structure	Stillwater/East Ranges, Nev.	R. Reeves/Kover	X			X					X	X					X	
	Faults, Lithology	7) Coast Ranges, Ore.	P. D. Snavely	X				X				X							
	Faults, Lithology	8) Southern Oregon	P. D. Snavely/G. Walker	X				X				X							
	Faults, Earthquake	24) San Andreas Fault	R. E. Wallace, R. D. Brown	X				X				X							
	Faults, Thermal areas	64) Central Cascade Range	P. D. Snavely	X				X				X							
	Folds, Faults, Major Uplifts and Intrusions	17) Baltimore (Harford-York) Md, Pa	D. L. Southwick, J. C. Reed	X				X				X							
	Folds, Faults, Major Uplifts and Intrusions	18) Hagerstown (Md, Pa, Va)	J. C. Reed, D. L. Southwick	X				X				X							
	Structure, stratigraphy	21) Battle Mtn., Nev.	M. Crittendon/R. Roberts	X				X				X							
	Structure, stratigraphy	34) Ouchita Mtns.	L. F. Dellwig (U. Kans)	X				X				X							
	Structure, stratigraphy	38) Great Sage Plain, Utah	D. Shawe, A. Brokaw	X				X				X							
	Structure, stratigraphy-orogeny	39) Eastern Beartooth Mtns, Wyo.	D. V. Wise, (F&M Coll.)	X				X				X							
	Structure, stratigraphy	45) Orange, Va.	L. F. Dellwig (U. Kans)	X				X				X							
	Engineering geology, structure	52) Nevada Test Site (AEC)	R. H. Morris	X				X				X							
	Structure, stratigraphy, lithology, orogeny	53) Spanish Peaks, Colo Cedar City, Utah	T. Stevens, D. Wyant, R. Hackman	X				X				X							
		54) Smoke Creek Desert Heber, Utah	M. Crittenden, E. Roberts	X				X				X							
	Earthquake zone	59) Tobin Range, Nev.	D. B. Slemmons (U. Nev.)	X				X				X							
	Earthquake zone	60) Dixie Valley, Nev.	D. B. Slemmons (U. Nev.)	X				X				X							
	Structure	73) Lynn Dist., Nev.	R. Roberts, R. Erickson K. Ketner																
	Mineralogy, structure	75) Goldfield, Nev.	J. Albers	X				X				X							
	Structure	80) Big Pine Fault, Cal	D. B. Slemmons (U. Nev.)	X				X				X							
	Structure	81) Mt. Morrison Fault, Calif.	D. B. Slemmons (U. Nev.)	X				X				X							
	Earthquake zone, structure	83) Mississippi Valley	J. P. D'Agostino	X				X				X							

1/ HOURS INDICATED ARE MINIMUM (1-1 HR. OR LESS) INSTRUMENT TIMES OVER SITE BASED ON AIR SPEED 200 MPH

2/ MOST AREAS LISTED FOR 1966 NEED TO BE FLOWN ONLY ONCE, UNLESS OTHERWISE INDICATED

● To be flown by special contract
Total Hrs. 8700

(X) Indicates primary instruments; others serve for backup data

INSTR *
MC-M...
IRS-In...
LAS-La...
Em...

…E CONDUCTED BY (1) AIRCRAFT AND (2) SPACECRAFT DATA GATHERING SYSTEMS (Continued)

PRINCIPAL DATA GATHERING INSTRUMENTS REQUIRED													AIRCRAFT OVERFLIGHT* HOURS REQUIRED PER CY																SPACECRAFT OVERFLIGHT DESIRED			
IRI	IRS	MWI	MWS	RAD (I)	RAD (A/S)	LAS	MAG	GRAV	UHF	UV	ABS	ON GROUND READOUT	1966				1967				1968				1969				1969	1970	1971	1972
		X	X	X	X		X			X	X			2															YES	OPEN	OPEN	OPEN
X				X						X	X			1															YES			
X				X						X	X			3															YES			
X	X			X	X					X	X			1															YES			
X	X			X	X					X	X			1															YES			
X	X			X	X						X			1															YES			
X	X			X	X						X			2															YES			
X				X						X	X		1																YES			
X				X						X	X		1																YES			
X				X			X				X				3														YES			
X				X			X				X				3														YES			
X				X										1															YES			
(X)				X			X				X			1															YES			
(X)	X	X	X	X					X		X				2														YES			
X											X				2														YES			
X	X	X	X	X	X		X		X	X	X				10					10									YES			
X	X	X	X	X					X					1															YES			
X	X	X	X	X			X		X		X			3					3										YES			
																													YES			
X	X	X	X	X											1														YES			
																													–			
X	X			X			X		X	X	X				3				3			3							YES			
X	X			X			X				X			3																		
X				X	X										1																	
X				X											1																	
X	X	X	X	X					X									3														
X	X	X	X	X	X				X						12					12												
X	X	X	X	X	X										1			1			1		1						YES			
X	X	X	X	X	X											10	10			15	15			15	15				YES			
X	X	X	X	X	X		X		X		X							20	20			30	30						YES			
X	X	X	X	X	X					X										24	24			30	30				YES			
												TOTAL HOURS PER QTR	2	67	118	105	50	115	143	81	66	72	136	105	47	40	105	52				
												TOTAL HOURS PER CY	293				389				379				244							
												TOTAL HOURS PER FY	69		389				362				328				157					

…ATIONS LEGEND:

…PC-Panoramic Camera, UHR-Ultra-High Resolution Camera (Multispectral), MBS-Multiband Synoptic, IRI-Infrared Imaging, … MWI-Microwave Imaging, MWS-Microwave Radiometers, RAD (I)-Imaging Radar, RAD (A/S)-Radar Altimeter/Scatterometer, …Scatterometer, MAG-Magnetometer, GRAV-Gravity Gradiometer, UHF-Radio Frequency Pulsed Radar, UV-Ultraviolet Absorption/ …rption Spectroscopy

CHART 3a.

GEOLOGIC LIST OF NATURAL RESOURCE EXPERIMENTS TO BE CONDUCTED BY (1) AIRCRAFT AN

TYPE OF EXPERIMENT	SPECIFIC APPLICATION (OR GEOSCIENCE PROBLEM) AND PARAMETERS TO BE MEASURED. INTERPRETIVE FEATURES TO BE STUDIED	TEST SITES TO BE UTILIZED	AGENCY, INSTITUTION AND INVESTIGATOR(S) RESPONSIBLE FOR DATA ANALYSIS	PRINCIPAL DATA GATHERING INSTRUMENTS REQUIRED															
				MC	PC	UHR	MBS	IRI	IRS	MWI	MWS	RAD (I)	RAD (A/S)	LAS	MAG	GRAV	UHF	UV	AB
Mineral Deposits	Fault zones, Rock Types (gross) alteration zones	1) Cedar City (Iron Springs) Utah	L. S. Hilpert	X	X		X	X	X	X	X	X	X		X			X	X
		5) Eureka (Tintic Dist) Utah	H. Morris/T. Lovering	X			X	X				X						X	X
		6) Salt Lake Dist, Utah	M. Crittenden/R. Roberts	X			X	X				X						X	X
		9) San Francisco Dist, Utah	L. S. Hilpert	X			X	X	X			X	X					X	X
		10) Carson City (Comstock) Nev.	Don White/Geo. Thompson	X			X	X	X			X	X					X	X
		13) Silver City (Central Dist) N. M.	E. Tooker	X			X	X	X			X	X						X
		37) Ouray-Silverton-Creede Dist, Colo.	T. Stevens/E. Baltz	X			X	X	X			X	X						X
		15) Twin Buttes (Piena Dist) Ariz.	J. Cooper, F. Simons, F. Canney	X			X	X				X						X	X
		22) Tonapah	H. Cornwall, P. Theobold	X			X	X				X						X	X
		41) Mesabi Iron Range	P. Sims, R. G. Reeves	X			X	X				X			X				X
		42) Gogebic Iron Range	W. Prinz, R. G. Reeves	X			X	X				X			X				X
		79) Matewan Coal Field, Ky.	D. C. Alvord	X			X	X				X							
		83) Ironton (S) Mo.	P. W. Guild	X			X	(X)				X			X				X
		89) Blackbird Dist., Idaho	F. C. Canney	X	X	X	(X)	(X)	X	X	X	X					X		X
		94) NE Pennsylvania Peat	C. Cameron	X		X	X	X											
		57) Hawaii	R. Reeves/A. Kover	X	X	X	X	X	X	X	X	X	X		X		X	X	X
		90) Alberton, Mont.	J. D. Wells	X	X	X	X	X	X	X	X	X					X		
		91) Tobacco Root Mtns, Mont.	A. Agnew	X	X	X	X	X	X	X	X	X			X		X		X
STRATIGRAPHY-SEDIMENTATION		51) Mesquite Sed. Site Ariz.	J. Lintz (U. of Nev.) T. Wutten (WWU)	X	X	X	y	X	X	X	X	X							
General Geologic	A) Inclusive (Lithologic composition, structure, stratigraphy, thermal springs	11) Yellowstone Nat'l	A. Campbell, staff	X			X	X	X			X			X		X	X	X
		23) Inyo Nat'l Forest, Calif.	P. Bateman	X			X	X	X			X			X				X
	Engineering problems, aggregate	70) Hopkinton-Milford, Templeton Orange	R. Oldale, L. Page	X				X				X	X						
		78) Cleveland Co., N. C.	W. C. Overstreet	X			X	X				X							
		93) Puerto Rico	R. P. Briggs	X	X	X	X	X	X	X	X	X					X		
		North Slope, Alaska	A. Kover/G. Gryc	X	X	X	X	X	X	X	X	X	X				X		
General Geology Additions	Foreign sites	Pinacate Hills, Mex.	G. Ulrich/Others	X	X	X	X	X	X	X	X	X	X						
		Central Mexico	G. Salas/K. Segerstrom	X	X	X	X	X	X	X	X	X	X						
		Quad. Ferrifero, Brazil	J. Dorr/R. Reeves	X	X	X	X	X	X	X	X	X	X		X		X		X
		Alice Springs, Australia	R. Lyon	X	X	X	X	X	X	X	X	X	X					X	

TOTAL HOU

TOTAL HOU

TOTAL HOU

This chart reflects the needs of the U. S. Geological Survey and the geologic community compiled by the U. S. Geological Survey

(X) Indicates primary instruments; others serve for backup data

* Unless otherwise indicated

INSTRUMENT ABBREVIATIONS LEGEND:

MC-Metric Camera, PC-Panoramic Camera, UHR-Ultra-High Resolution Camera (Multispectral), MBS-
IRS-Infrared Spectral, MWI-Microwave Imaging, MWS-Microwave Radiometers, RAD (I)-Imaging Ra
LAS-Laser Altimeter/Scatterometer, MAG-Magnetometer, GRAV-Gravity Gradiometer, UHF-Radio Frequ
Emission, ABS-Absorption Spectroscopy

...NTS TO BE CONDUCTED BY (1) AIRCRAFT AND (2) SPACECRAFT DATA GATHERING SYSTEMS

PRINCIPAL DATA GATHERING INSTRUMENTS REQUIRED													AIRCRAFT OVERFLIGHT HOURS REQUIRED PER CY																SPACECRAFT OVERFLIGHT DESIRED			
[illegible]	IRS	MSYI	MWS	RI	RA/S	LAS	MAG	GRAV	UHF	UV	ABS	ON GR'ND READOUT	66				67				68				69				68	69	'70	71
X	X		X	X						X		NO	5	5	5	5	5	5	5	5	5	5	5	5	15		15		YES	YES	YES	YES
	X											NO	15		15		15		15		15		15		15		15		YES	YES	YES	
[illegible]		X	X	X	X					X		NO	15		15		15		15		15		15		15		15		YES	YES	YES	
X		X		X						X		NO	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	YES	YES	YES	
												NO	5	5	5	5	10	10	10	10	10	10	10	10					YES	YES		
												NO					5	5	5	5	10	10	10	10	10	10	10	10	YES	YES	YES	
X	X	X	X	X								NO	5		5		25		25		25		25		25		25		YES	YES	YES	YES
												NO	5		5		5		5		5		5		5		5		YES	YES	YES	YES
X												NO		0				0				0				0			YES	YES	YES	YES
X	X	X	X	X	X							NO	5	5	5	5	25		25		25		25		25		25		YES	YES	YES	YES
X	X	X	X	X								NO	5		5		5	5	5	5	5	5	5	5	5	5	5	5	YES	YES	YES	YES
						X								0				0				0				0			YES	YES		
X	X	X	X	X	X							NO	UNKNOWN UNTIL INSTRUMENTS ARE DEVELOPED																			
												NO		0				0				0				0			YES	YES	YES	YES
X	X	X	X	X	X			X	X			NO						12	12			15	15			20	20		YES	YES	YES	YES
X	X	X	X	X	X							NO								10	10			15	15			20	YES	YES	YES	YES
												TOTAL HOURS PER QTR	170				328				365				355							
												TOTAL HOURS PER CY	65	20	65	20	115	42	127	44	130	50	135	50	135	40	140	40				
												TOTAL HOURS PER FY	85		242				359				360				180					

...Camera (Multispectral), MBS-Multiband Synoptic, IRI-Infrared Imaging, ...Radiometers, RAD (I)-Imaging Radar, RAD (A/S)-Radar Altimeter/Scatterometer, ...Gravimeter, UHF-Radio Frequency Pulsed Radar, UV-Ultraviolet Absorption/

CHART 4.

HYDROLOGIC LIST OF NATURAL RESOURCES EXPERIMENTS TO BE CONDUCTED BY (1) AIR

TITLE OF EXPERIMENT	SPECIFIC APPLICATION (OR GEO-SCIENCE PROBLEM) AND PARAMETERS TO BE MEASURED	TEST SITES* TO BE UTILIZED	AGENCY, INSTITUTION AND INVESTIGATOR(S) RESPONSIBLE FOR DATA ANALYSIS	PRINCIPAL DATA GATHERING INSTRUMENTS REQUIRED															
				MC	PC	UHR	MB	IRI	IRS	MWI	MWS	RI	RA/S	LAS	MAG	GRAV	UHF	UV	AB
Measurement of evapotranspiration	Determine the loss of water to the atmosphere from open water surfaces and vegetated land	* Salton Sea * Willcox Playa Gila River Valley	USGS H. E. Skibitzke				X	X	X		X	X						X	
Measurement of water surface roughness	Determine the distribution of oxygen and water pollutants in the near-surface environment	* Salton Sea Lake Erie Great Salt Lake Cachuma Reservoir	USGS H. E. Skibitzke C. L. McGuinness C. J. Robinove W. J. Schneider	X		X			X										
Rainfall distribution and infiltration patterns	Measurement of rainfall and its distribution and prediction of runoff and infiltration for water-management purposes	Parts of Arizona to be selected	USGS H. E. Skibitzke	X	X	X	X	X		X	X	X	X					X	
Ground-water discharge	Identification of reaches of streams where sizable discharges of ground-water occur as a means of location and mapping productive aquifers	Coos Bay, Oregon Other sites to be selected	USGS H. E. Skibitzke		X	X	X	X		X		X						X	
Identification of subaqueous features	Observe changes in time of bottom sediments, topography, and biota of lakes and reservoirs as a guide to water measurement practices	Salton Sea Great Salt Lake Lake Erie Everglades Other sites to be selected	USGS H. E. Skibitzke W. J. Schneider	X	X	X	X												
Salt content of water and light absorption	Monitoring and predicting salt-water concentration in estuaries for pollution control	Delaware River Estuary -- Other sites to be selected	USGS H. E. Skibitzke			X	X												
Water pollution	Measure and map repetitively organic, inorganic, and thermal pollutants in water to monitor hazardous or undesirable factors in water supply	Lake Erie Chesapeake Bay Mississippi River	USGS To be selected		X	X	X	X	X	X	X	X							
Reservoir sedimentation	Repetitive measurement of sediment deposition in reservoirs as a means of devising sediment control programs and structures	To be selected	USGS To be selected		X	X	X												
Effluents of major rivers	Map the distribution and extent of fresh water and suspended matter in order to understand the movement of currents and definition of sediment on the ocean bottom	Will be in U. S. but not selected yet Eventual world-wide study	USGS R. H. Meade		X	X	X	X											
Runoff and water retention characteristics of drainage basins	Measurement and mapping of the topographic, geographic, geologic, vegetal, and cultural features of drainage basins that influence runoff, soil moisture, and ground-water recharge in order to develop a capability for long term predictions of water availability	Salton Sea Chad Basin	USGS To be selected	X	X	X	X	X	X	X	X	X	X						
Water regimen of valley glaciers	Determine the hydrologic controls on valley glaciers as sensitive indicators of climate and as sources of water supply	* South Cascade Glacier	USGS Mark Meier	X	X	X	X	X	X	X	X	X							
Monitoring lake and reservoir levels	Obtain synoptic measurements of the stage of significant lakes and reservoirs	To be selected	USGS To be selected		X	X								X					
Snow surveying	Development of devices to map synoptically the water content of winter snowpack in western mountain regions as an aid to water supply and flood forecasting	To be selected	USGS To be selected	X	X	X		X	X	X	X	X	X						
Accelerated erosion and sedimentation	measure and map synoptically the natural and cultural changes in the hydrologic regimen of drainage basins that influence the amount and rate of change of flood runoff and sediment production	To be selected	USGS To be selected																
Hydrologic cycle of a tropical area	Multisensing to measure soil moisture, water movement and cultural features of drainage basins	Quadrilatero Ferrifero, Brazil	USGS/U. of Nevada	X	X	X		X	X	X	X	X	X			X	X		
Hydrologic cycle of a desert area	Multisensing to measure soil moisture, water movement and cultural features of drainage basins	Alice Springs, Australia	Govt. of Australia (CSIRO) Indiana U. A. F. Agnew	X	X	X		X	X	X	X	X	X						

TOTAL HC

. This chart reflects the needs of the U. S. Geological Survey and the hydrologic community compiled by the U. S. Geological Survey

TOTAL HC

TOTAL HC

INSTRUMENT ABBREVIATIONS LEGEND:

MC-Metric Camera, PC-Panoramic Camera, UHR-Ultra-High Resolution Camera (Multispectral), MBS-Multiband Synoptic, IRI-Infr
IRS-Infrared Spectral, MWI-Microwave Imaging, MWS-Microwave Radiometers, RAD (I)-Imaging Radar, RAD (A/S)-Radar Altimeter/S
LAS-Laser Altimeter/Scatterometer, MAG-Magnetometer, GRAV-Gravity Gradiometer, UHF-Radio Frequency Pulsed Radar, UV-Ultr
Emission, ABS-Absorption Spectroscopy

TO BE CONDUCTED BY (1) AIRCRAFT AND (2) SPACECRAFT DATA GATHERING SYSTEMS

	PRINCIPAL DATA GATHERING INSTRUMENTS REQUIRED												AIRCRAFT OVERFLIGHT HOURS REQUIRED																SPACECRAFT OVERFLIGHTS DESIRED															
	IRS	MWI	MWS	RAD I	RAD A/S	LAS ALT	MAG	GRAV	UHF	UV	ABSS	ON GRND READOUT	1966				1967				1968				1969				1969				1970				1971				1972			
					(X)					X		X	15		10					10			10		10				X				X			X				X			X	
				(X)								X					10		10				10								X				X				X			X		
						(X)												5			5																X				X			X
																				10					5							X		X				X			X			X
			X									X	10		10		10		10	10			20		5					X				X				X			X			X
	X	(X)	X												5				5						5					X				X				X			X			X
	X	(X)	X					X				X			5				5								5			X				X				X			X			X
	X	(X)	X													10			5											X				X				X			X			X
	X			(X)	X	(X)								20				20			20						10							X	X			X			X			X
		(X)		X					X									10			10	20		10										X	X			X			X			X
		X	(X)	(X)	X	X			X								10				10		20											X	X		X	X			X	X		
				(X)	X	(X)	X	X								10							10			10			X		X		X	X		X			X				X	
	X	X	(X)											10							5					10		10		X				X				X			X			X
				X				X								5			5	5						5	10	10	X	X		X			X				X			X		
	X		X						X							5			5	5			10			10	10	10		X				X				X			X			
		(X)					X	X		X										*			*		*					X				X				X						
						(X)		X				X										5			10		10										X				X			X
X		X								X	X	X			*	*			*	*		*		*		*				X				X				X			X			
					X							X								5																	X							
												TOTAL HOURS PER QTR	25	30	30	40	30	45	45	45	40	40	60	30	35	35	45	30																
												TOTAL HOURS PER CY	125				165				170				145																			
												TOTAL HOURS PER FY	55		145				170				160				75																	

Utilization of fundamental and overflight sites partially restricted to high inclination or polar orbits.

...ific community

...R. UHR-Ultra-High Resolution Camera (Multispectral), MBS-Multiband Synoptic, IRI-Infrared Imaging, ...Imaging, MWS-Microwave Radiometers, RAD (I)-Imaging Radar, RAD (A/S)-Radar Altimeter/Scatterometer, ...Magnetometer, GRAV-Gravity Gradiometer, UHF-Radio Frequency Pulsed Radar, UV-Ultraviolet Absorption/

CHART 5.

OCEANOGRAPHIC LIST OF NATURAL RESOURCES EXPERIMENTS TO BE CONDUCTED BY (1) AIRCRAFT

TITLE OF EXPERIMENT	SPECIFIC APPLICATION (OR GEOSCIENCE PROBLEM) PHENOMENA AND PARAMETERS TO BE MEASURED, INTERPRETATIVE FEATURES TO BE STUDIED	TEST SITES TO BE UTILIZED	AGENCY, INSTITUTION AND INVESTIGATOR (s) RESPONSIBLE FOR DATA ANALYSIS	PRINCIPAL DATA GATHERING INSTRUMENTS REQUIRED															
				MC	PC	MBS		IRI	IRS	MWI	MWS	RAD I	RAD A/S	LAS ALT	MAC	GRAV	UHF	UV	ABSS
Wave height measurement by radar backscatter	Sea state measurement	Argus Island 0-2	New York University Dr. J. Pierson, Jr.	X	X	X							(X)					X	
Wave profile determination by imaging radar		Argus Island 0-2	New York University Dr. W. J. Pierson, Jr.	X	X	X						(X)							
Wave profiles by laser		Scripps pier 0-1		X	X	X								(X)					
Wave length study from photography		Navy acre 0-8	M. I. T. Dr. Markey	X	(X)	X													
Measurement of absolute temperature and determination of probable error and corrections	Sea surface temperature measurement	Argus Island 0-2 Scripps Pier 0-1	Navoceano Beckner Dr. McAlister						X	(X)	X								
Location of water masses, fronts and gradients	Thermal mapping and surface roughness	Northern Gulf Stream 0-9	University of Miami Dr. Singer		X			(X)	X	(X)	X								
Location and identification of offshore currents	Location and "Mapping" of currents	Northern Gulf Stream 0-9	WHOI Dr. G. C. Ewing	X	(X)			(X)	X	(X)	X					X			
Location and mapping of longshore currents		Scripps Pier 0-1	Univ. of Washington Dr. Flemming	X	(X)			(X)	X	(X)	X								
Ice mapping, determination and measurement of ice features	Sea ice applications	Point Barrow 0-3 0-4 Goose Bay	Navoceano/CRREL W. I. Wittmann Poulin.	(X)	X	(X)		(X)	X			(X)	X	(X)					
Thermal mapping and determination of land/water/ice/snow interface		Point Barrow 0-3 0-11 Baffin Bay	Navoceano W. F. Wittmann					(X)		(X)		X					X		
Detection and classification of icebergs	Icebergs	Grand Banks 0-10 0-11 Baffin Bay	Unassigned U. S. Coast Guard Comdr. Lencryk	(X)	X	X				X	(X)	(X)	X	X			X		
Coastal geology and geography	Shoreline and beach studies	Scripps Pier 0-1 0-7 Florida Straits	ESSA R. Nelson	(X)	X	(X)						(X)	X	(X)	X	X			
Fresh water discharge and pollution areas	River discharge and Delta studies	Miss Delta 0-6 0-5 Columbia River	Texas A&M Dr. D. Liepper Univ. of Washington Mr. C. Banks	(X)	X	(X)		(X)	X	X	(X)								
Bottom detection by wave refraction and color tones	Mapping - bathymetry - removal of doubtful soundings	Scripps Pier 0-1 0-7 Florida Straits	M. I. T./ESSA Dr. Markey/Nelson	X	(X)	X						X				X			
Feasibility of detecting and interpreting bioluminesence plankton, redtide & fish schools	Biological studies	Scripps Pier 0-1 0-7 Florida Straits	B. C. F. T. Auston	X	(X)	(X)			X		X						X		
Detection of volcanic activity by IR and MW	Geology	Argus Island 0-2	ESSA R. Nelson	X	X	X		(X)		(X)					X	X		X	
Altimetry by laser	Altimetry & Sea slope	Scripps Pier 0-1	CRREL Dr. Rinker ?											(X)		X			
Thickness and effect of humid air column, clouds fog ect	Air - sea interaction	Argus Island 0-2	M. I. T. Dr. Markey	X	X	X		X		X								X	X
Tracking of floating buoys	Speed and direction of ocean currents	Navy acre 0-8	WHOI Dr. G. Ewing										X						

TOTAL HOURS P

TOTAL HOURS

TOTAL HOURS

(X) PRINCIPAL INSTRUMENTS

X BACKUP INSTRUMENTS

* CONCURRENT WITH OTHER EXPERIMENTS

This chart reflects the needs of the U. S. Naval Oceanographic Office and the Oceanographic community compiled by Spacecraft Oceanography Project

INSTRUMENT ABBREVIATIONS LEGEND:

MC-Metric Camera, PC-Panoramic Camera, UHR-Ultra-High Resolution Camera (Multispectral), MBS-Multiband Synoptic, IRS-Infrared Spectral, MWI Microwave Imaging, MWS-Microwave Radiometers, RAD (I)-Imaging Radar, RAD (A/S)-Radar, LAS-Laser Altimeter/Scatterometer, MAG-Magnetometer, GRAV-Gravity Gradiometer, UHF-Radio Frequency Pulsed Radar, Emission, ABS-Absorption Spectroscopy